

Compressed Air Systems CEC Pre-Rulemaking Workshop

California Statewide Utility Codes and Standards Program

Energy Solutions
April 27, 2011

Air Compressors

Scope of Proposal

- Mandatory requirements for compressed air systems over 25hp in new construction and major renovations.

Air Compressors

Proposed Code Language

SECTION 127 – MANDATORY REQUIREMENTS FOR COMPRESSED AIR SYSTEMS

A compressed air system with a total system power of 25 horsepower (hp) or larger shall meet the requirements of this section. This section applies to construction projects for which an application for a building permit or renewal of an existing permit is filed (or is required by law to be filed), and where the total combined horsepower of the compressors is increased.

- (a) Controls Requirements. Compressed air systems with more than one compressor must operate with a controller that is able to choose the most energy efficient combination of compressors within the system based on the current air demand as measured by a sensor.

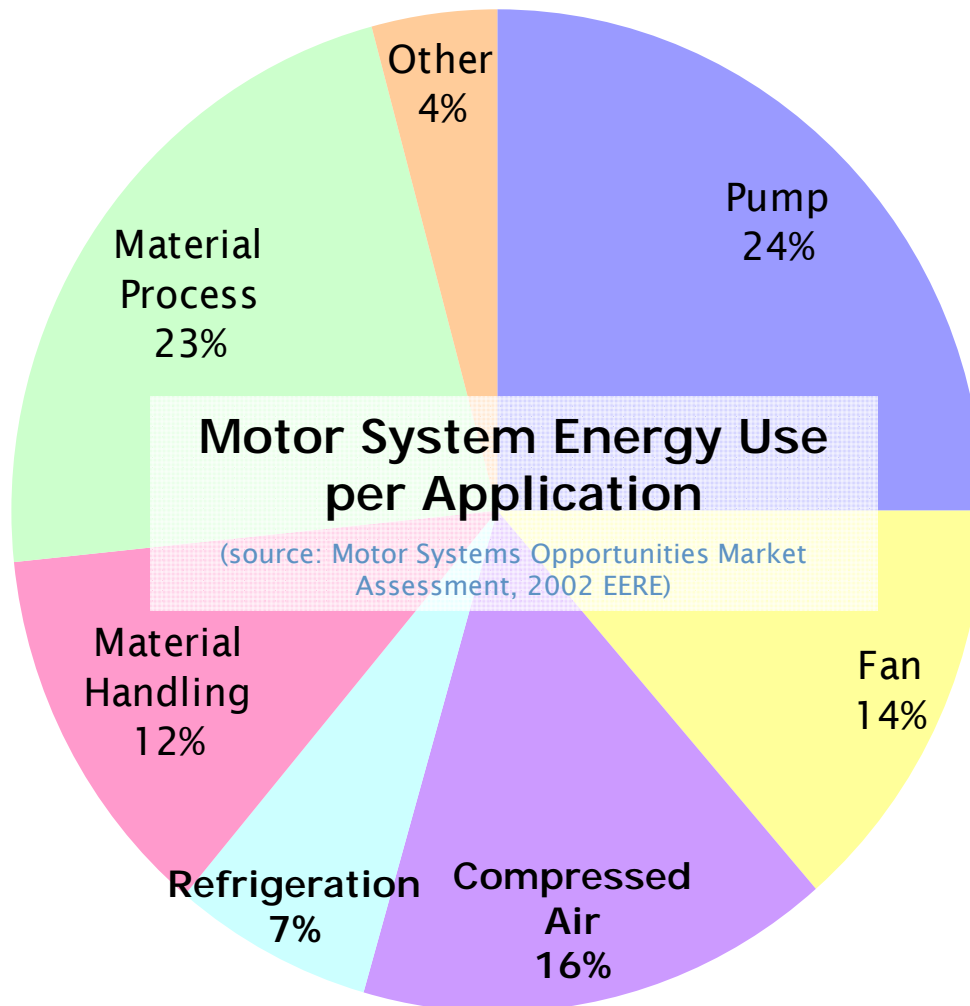
EXCEPTION to Section 127(a): Compressed air systems with a total system horsepower of 100 hp or less.

- (b) Trim Compressor Requirements. Compressed air systems shall include at least one compressor capable of maintaining 22 kW or less of input per 100 acfm of output throughout the usable trim load of the system.

EXCEPTION to Section 127(b): Compressed air systems in existing facilities.

Air Compressors

Why Compressed Air?



- 16 % of U.S. industrial motor systems energy in
- 10% of total industrial energy use
- ~90,000 GWh annual consumption
- With cost-effective measures, savings can be upwards of 17% or more (~15,000 GWh)
 - Measures with <3yr payback
 - Source: Assessment of the Market for Compressed Air Efficiency Services, EERE 2001

Many Possible Energy Efficiency Measures

- Require minimum compressor efficiency
- Reduce leaks to a maximum threshold
- Limit max pressure
- Max pressure drop
- Only condition enough air for the specific applications
- Primary receiver requirements
- Secondary receiver requirements
- Site compressors near loads
- Remove or close off unused lines
- Size compressors appropriately
- Increase piping and accessory sizes
- Use smooth bore piping
- Eliminate unnecessary bends in piping
- Compressor room ventilation
- Cool intakes
- Install adequate dryers
- Replaced compressed air with direct acting units
- Common head on all compressors
- Controls based on common head
- Filter requirements
- Cool compressor air intake with heat exchanger
- Recover waste heat
- Ban inappropriate uses
- Condensate trap standards
- Commissioning requirements
- Require cycling refrigerated dryers
- Max pressure drop in last 10 ft. before the end use
- Ban unregulated end uses
- Require submitting a system diagram
- Require generation and submitting a system pressure profile
- Require reporting about the system
- Require data logging
- Controls requirements
- Regulate total system efficiency
- Require pressure-flow controllers
- Require VFD for trim
- Require a maintenance plan

Air Compressors

Code Proposals

- Requirements for a full-range efficient trim compressor as the designated trim compressor on all compressed air systems
 - Based on VSD specifications
 - Allows for flexibility in technology
- Requirements for Smart System Controls on multi-compressor systems
 - Minimum requirements
 - Able to make decisions based on current demand
 - Various manufacturers and compressor types

Focusing on:

New Construction and Major Renovations
Permanent installations
Cost-effective system size threshold

Air Compressors

Methodology: Energy Savings (Smart Controls)

Baselines

- 4 Baselines
 - Different total size
 - 2 different load profiles
 - Matched to compressor makeup
 - Slight change
 - Load profiles normalized to compressor system capacity
 - Auto shutdown timers
- Baselines made with feedback from stakeholders

Modeling Plan

- Model each baseline in AirMaster+
 - Worked with certified AirMaster+ Instructor
- Apply Smart Controls manually
- Compare energy use to determine annual savings

Air Compressors

Methodology: Energy Savings (VSDs)

Baselines

- Load/Unload
Lubricant-Injected
Rotary Screw
with 2 gal/cfm
 - Based on feedback from stakeholders

Modeling Plan

- Modeling both VSDs and baseline with 2 gal/cfm
- Model each baseline with excel formulas
 - Technical information from AirMaster+
- Compare energy use per hour

Air Compressors

Methodology: Incremental Costs

Smart Controls

- Includes
 - Control Unit
 - Interfaces with Compressors
 - Sensors
 - Installation Labor
- Based on estimates from 3 manufacturers for the modeled baseline systems.

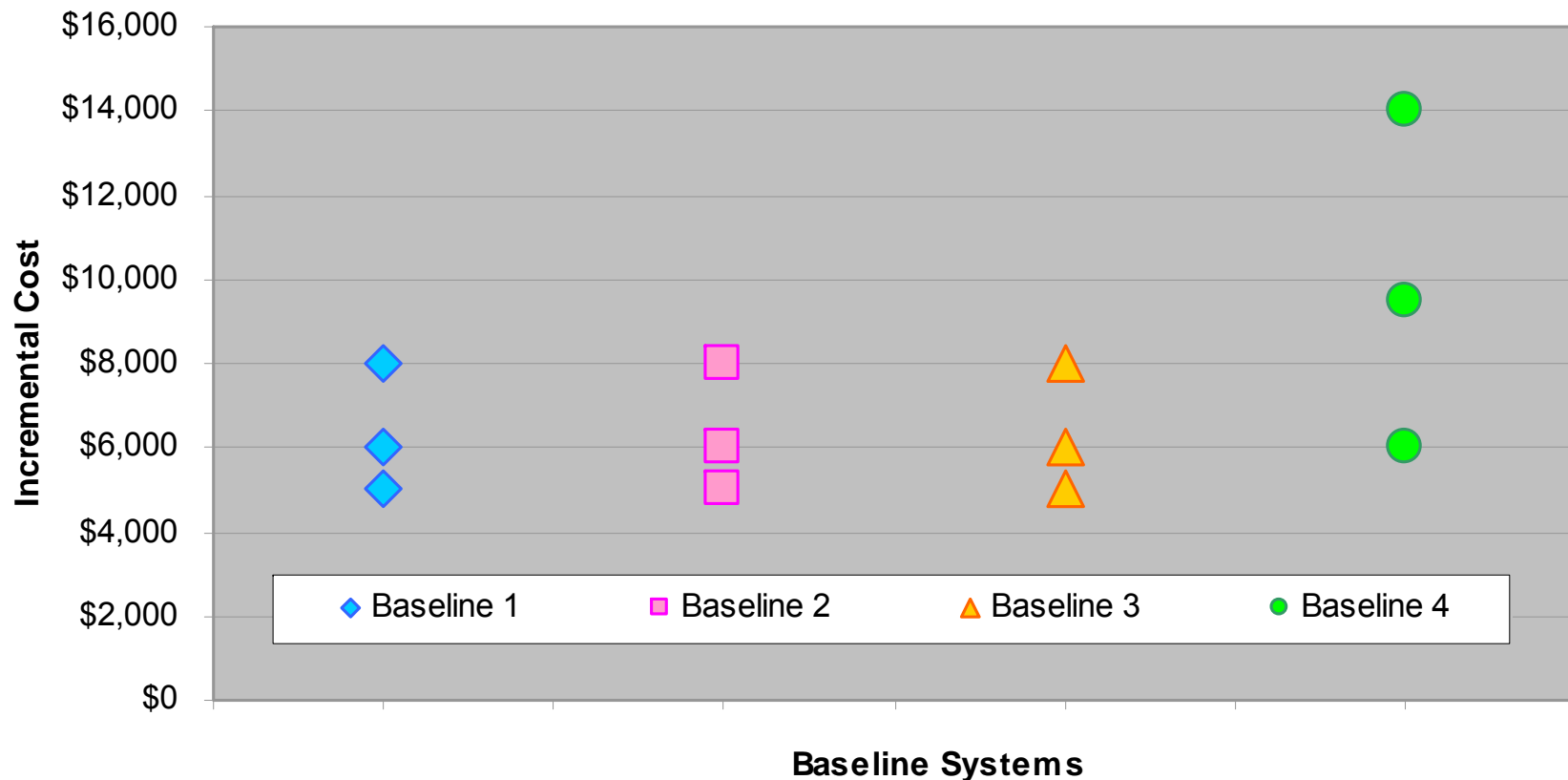
VSDs

- Costs are based on values from manufacturers.
- Includes a trendline for parametric analysis

Air Compressors

Methodology: Incremental Costs

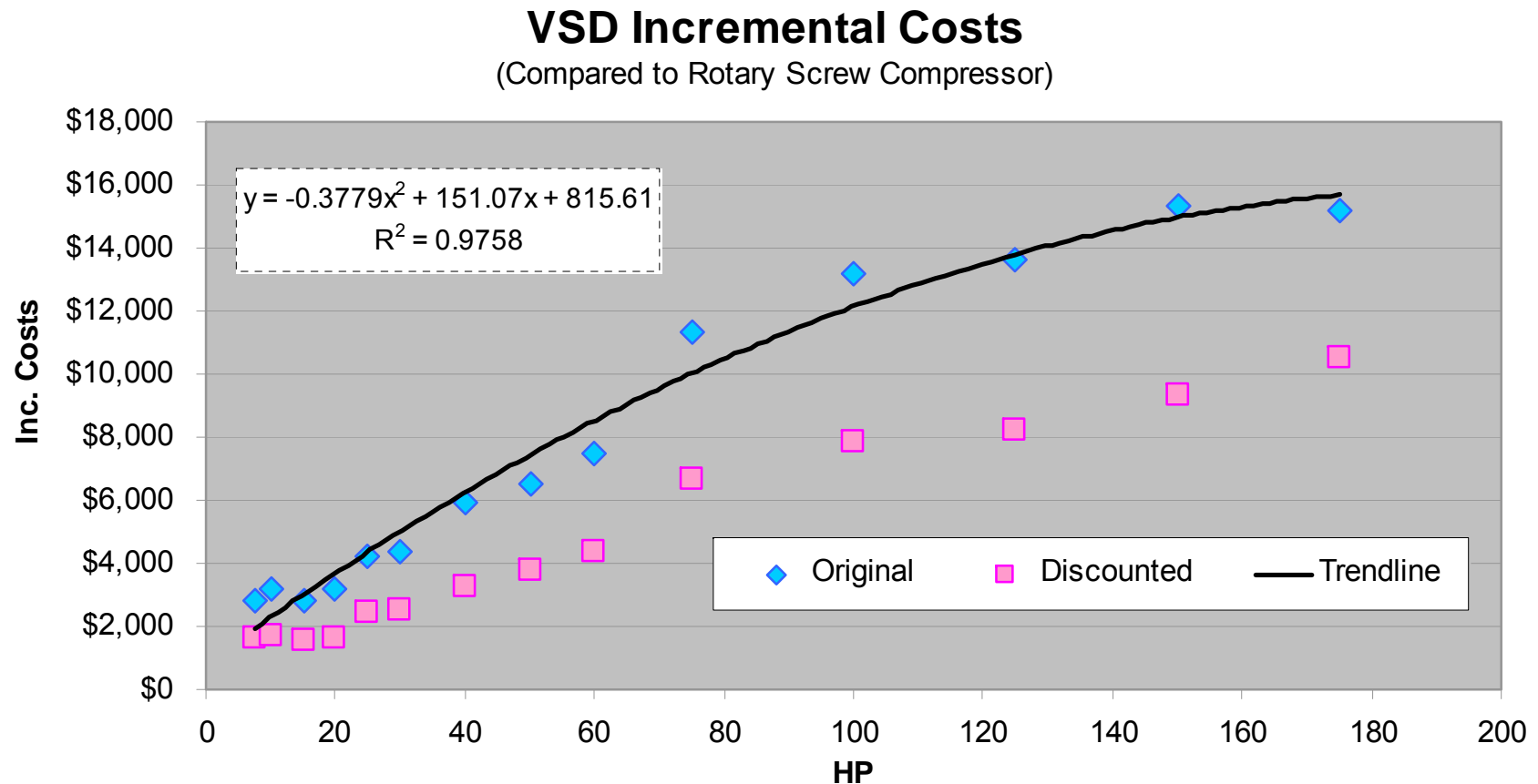
Manufacturer Estimated Costs to Add Smart Controls



*Other more expensive controllers exist on the market, but they include additional functionality beyond our requirements.

Air Compressors

Methodology: Incremental Costs



Air Compressors

LCC Analysis and Results (Smart Controls)

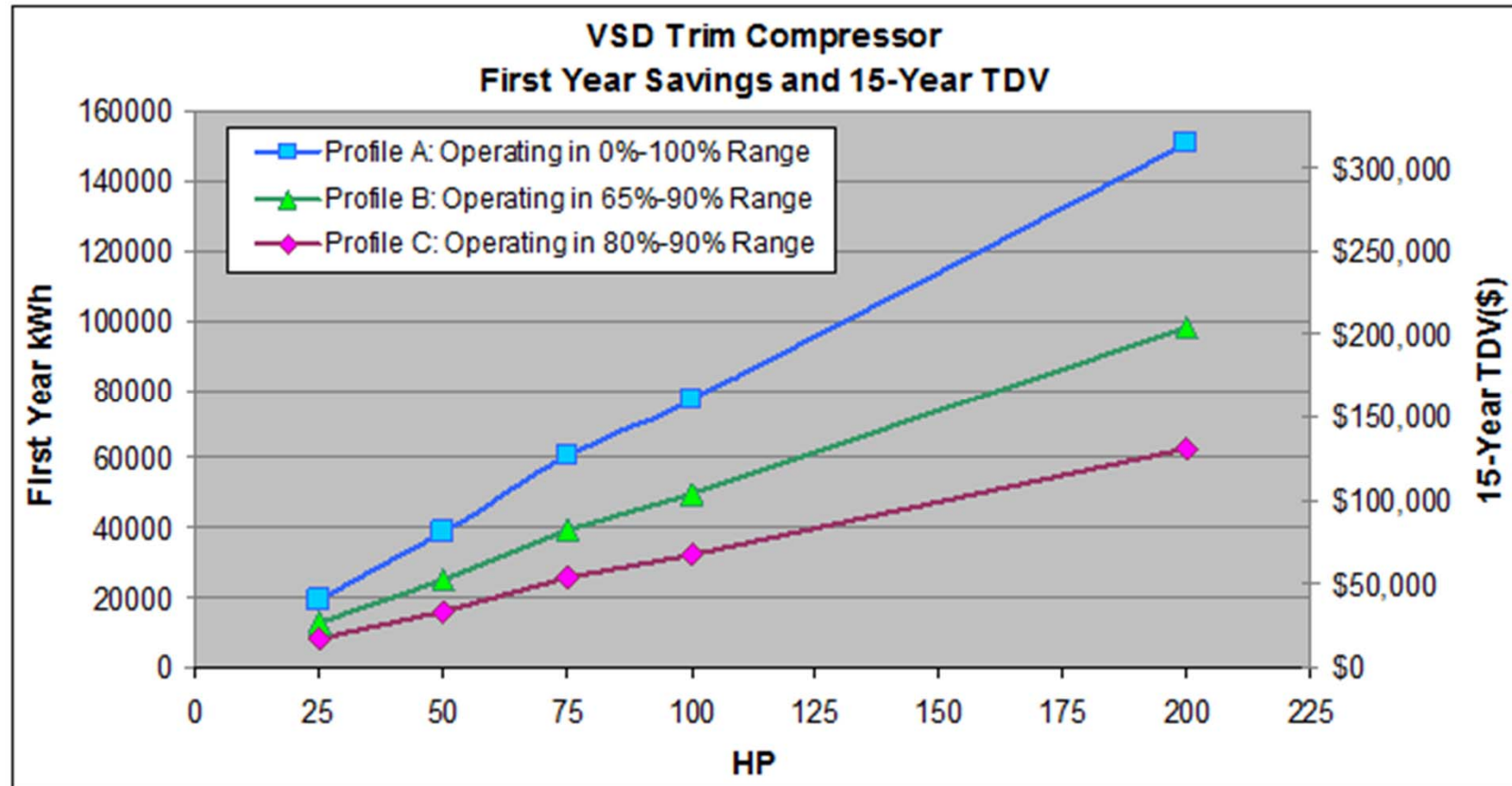
- Smart Controls are cost effective

Baseline		Incremental Costs	Energy Cost Savings (TDV\$)	LCC Savings
50 hp RS 75 hp RS	1	\$6,173	\$18,812	\$12,639
50 hp RS 150 hp RS	2	\$6,173	\$8,395	\$2,222
150 hp RS 300 hp RS	3	\$6,173	\$12,026	\$5,836
200 hp RS 300 hp RS 500 hp C	4	\$10,159	\$48,832	\$38,673

- Incremental costs have been averaged
- LCC not dependent on system size

Air Compressors

LCC Analysis and Results (VSDs)



Air Compressors

Renovation/Retrofit

- Smart Controls:
 - Mandatory for renovations/retrofits if the total combined horsepower of the compressors in the system is increased.
- VSDs:
 - Not mandatory for renovations/retrofits.

Air Compressors

Proposed Code Language

SECTION 127 – MANDATORY REQUIREMENTS FOR COMPRESSED AIR SYSTEMS

A compressed air system with a total system power of 25 horsepower (hp) or larger shall meet the requirements of this section. This section applies to construction projects for which an application for a building permit or renewal of an existing permit is filed (or is required by law to be filed), and where the total combined horsepower of the compressors is increased.

- (a) Controls Requirements. Compressed air systems with more than one compressor must operate with a controller that is able to choose the most energy efficient combination of compressors within the system based on the current air demand as measured by a sensor.

EXCEPTION to Section 127(a): Compressed air systems with a total system horsepower of 100 hp or less.

- (b) Trim Compressor Requirements. Compressed air systems shall include at least one compressor capable of maintaining 22 kW or less of input per 100 acfm of output throughout the usable trim load of the system.

EXCEPTION to Section 127(b): Compressed air systems in existing facilities.

Air Compressors

Part Load Performance Metrics

- Industry standard metrics for evaluating trim compressor part load performance?
- Current approach: For some continuous range X% of the compressor's total range, the compressor can deliver air at pressure using less than some efficiency performance value P kW/cfm at all points within the range.
- Possible trim compressor requirements:
 - X is 70% of the range
 - P is 22 kW/cfm (for 100 psi discharge, other pressure levels would require other P values)
- Other sources of VSD part load performance data beyond CAGI datasheets that should be included?

Air Compressors

Enforcement / Acceptance Testing

- Analysis assumes set-up process
- Is there a standard output from this set up process?



QUESTIONS & COMMENTS

Russell Torres

rtorres@energy-solution.com

510-482-4420 x269

Ransom Byers

rbyers@energy-solution.com

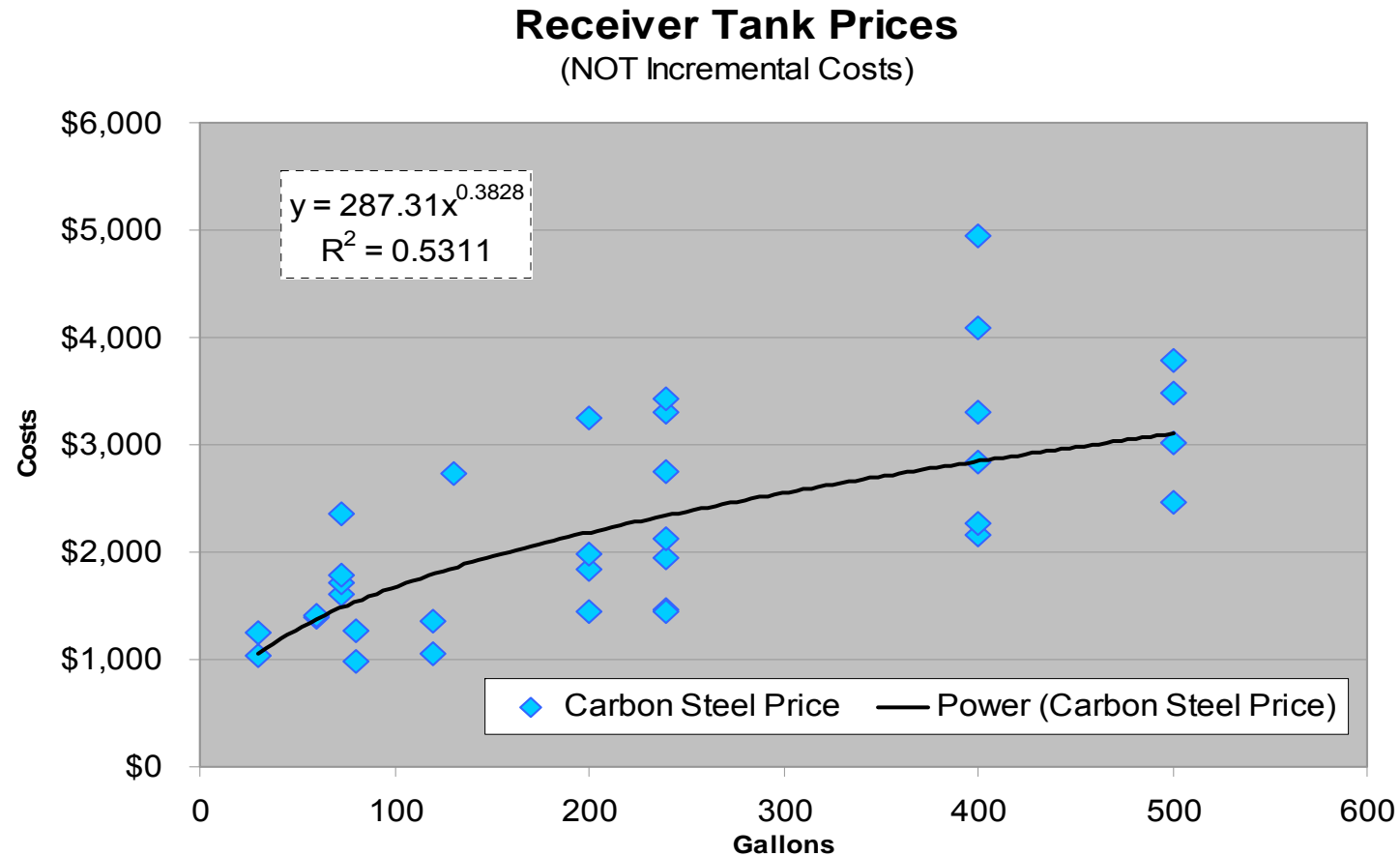
510-482-4420 x214

Air Compressors

Appendices

Air Compressors

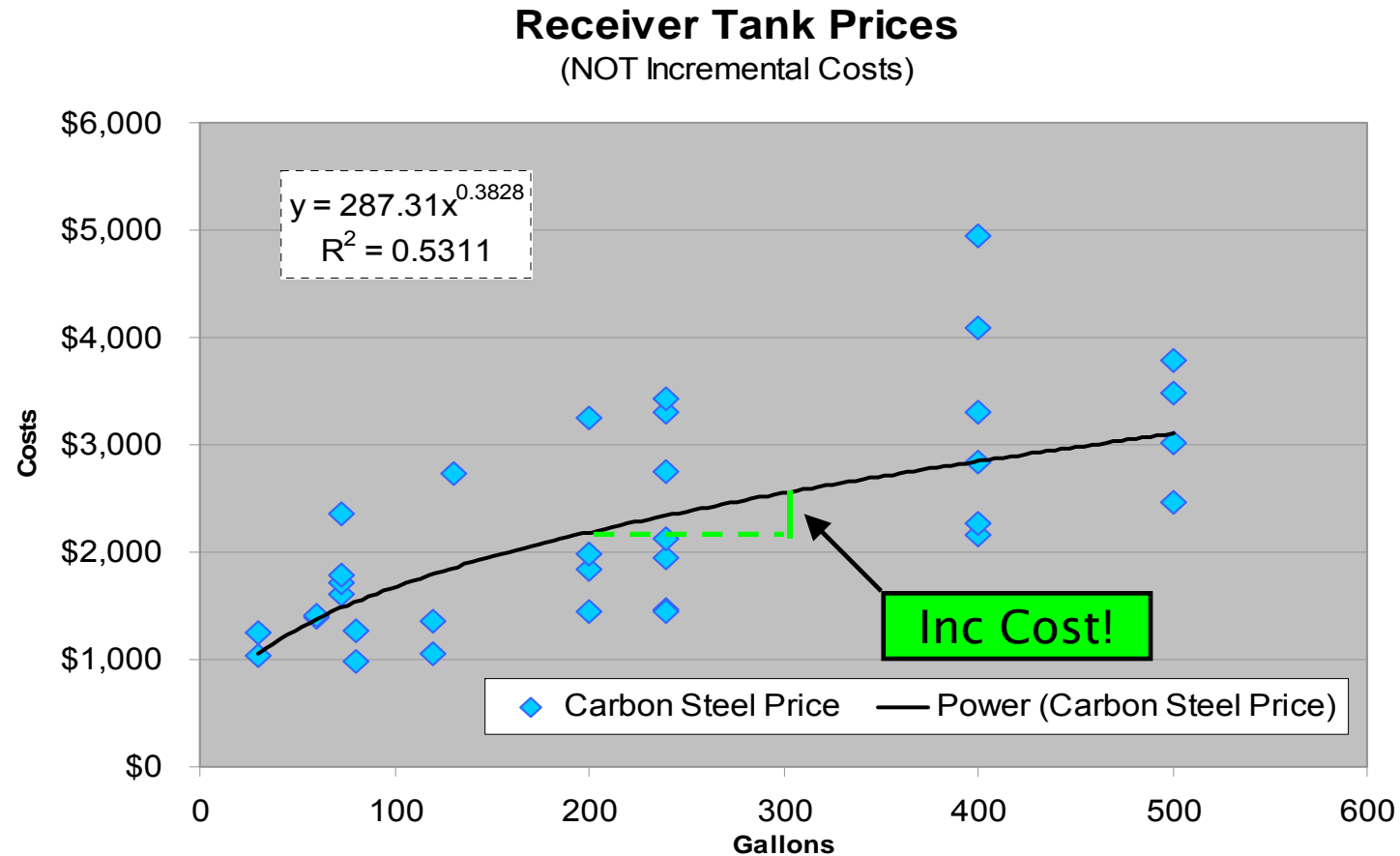
Methodology: Incremental Costs



Receiver Tanks: This is cost, not incremental cost

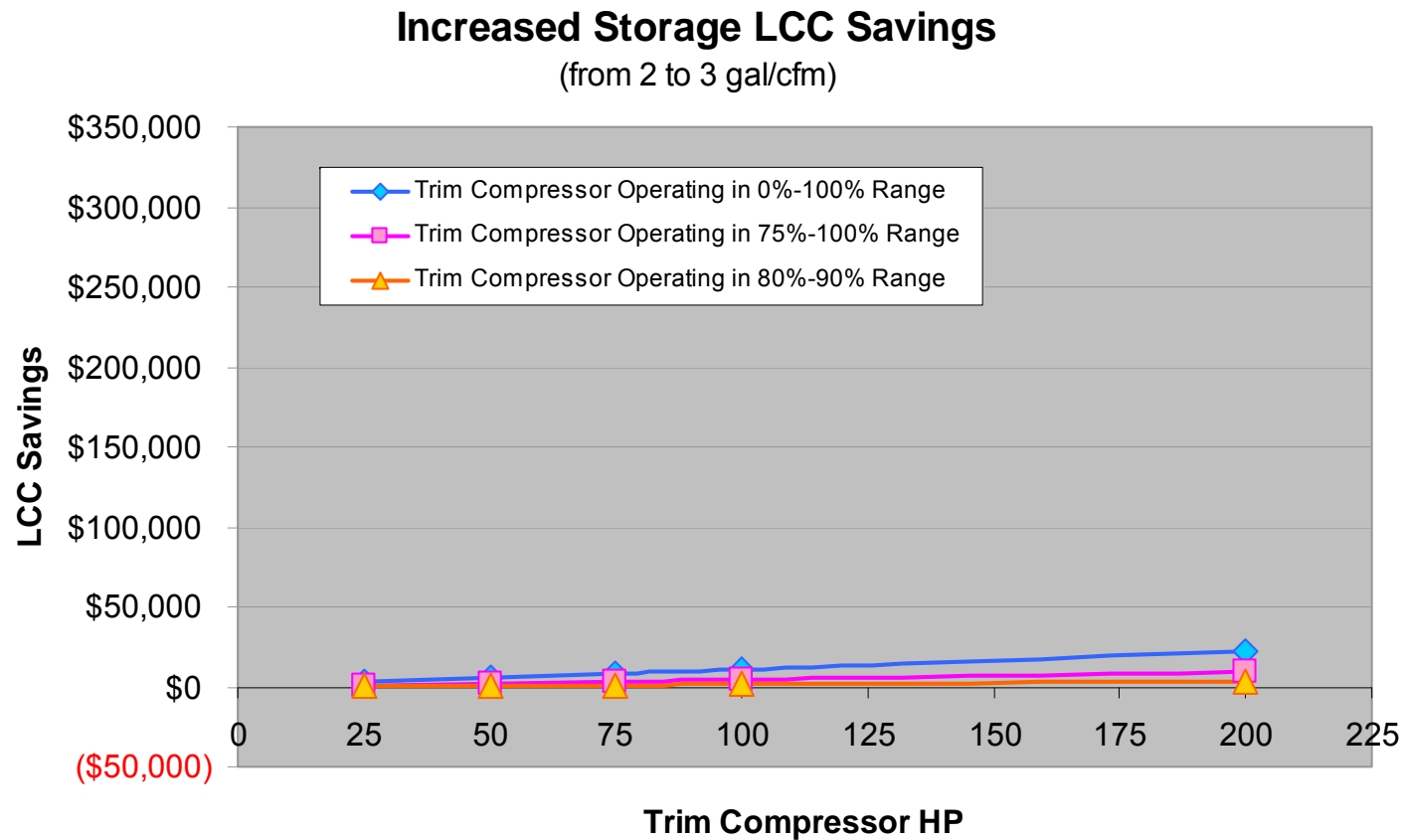
Air Compressors

Methodology: Incremental Costs



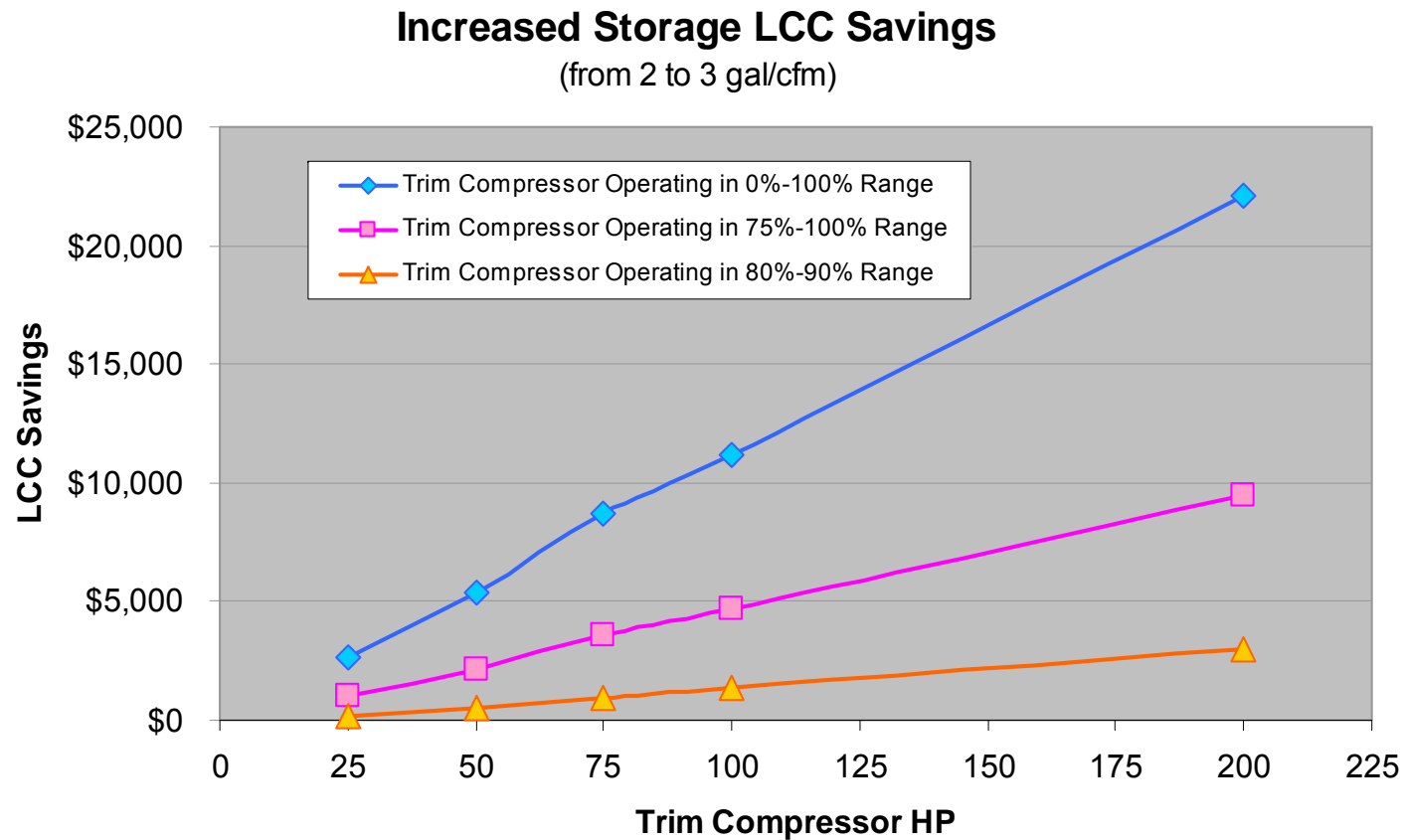
Air Compressors

LCC Analysis and Results (VSDs)



Air Compressors

LCC Analysis and Results (VSDs)



Scale adjusted for detail